I. Introduction

Birds of prey, also known as raptors, are important members of most terrestrial biological ecosystems. As carnivores, raptors generally exist at high trophic levels consuming other species that are either primary (herbivores) or secondary (omnivores or carnivores) producers. Because they occur at relatively high trophic levels, where toxic compounds are sometimes concentrated, raptors can be good indicators of system-wide pollution problems. Furthermore, presence or diversity of raptor species can be used to estimate whether or not habitat reserves or linkages are properly functioning (sustained high species diversity at many trophic levels). Conversion of native habitats to urban landscapes in southern California has placed increasing pressure on maintaining functional ecosystems within conserved habitats. Chino Hills State Park (CHSP) is important for conservation purposes because it provides a large habitat block, and remains as one of the few wildlife linkages between northeastern Orange, northwestern Riverside, and southwestern San Bernardino Counties.

At Chino Hills State Park, raptors utilize many different habitats. They feed on small mammals, snakes, lizards, amphibians, invertebrates, and birds, hunting in open vegetation. Nest sites occur in diverse settings including rock ledges, riparian trees and vegetation, grasslands and human introduced features (e.g., Eucalyptus trees, utility poles). Understanding of the species composition, and abundances of raptor species and their reproductive success (from monitoring nesting locations), will support conservation management decisions at CHSP. Additionally, information regarding raptor populations at CHSP will support region-wide habitat conservation and management efforts. The purpose of this study was to identify the distribution and abundance of nesting birds of prey at CHSP, and to provide baseline data and a monitoring framework to observe changes in their distribution and abundance over time. This effort also provides data on nest locations, nesting-pair numbers, and fledgling success.

Chino Hills State Park is located in part within three southern California counties: Orange, Riverside, and San Bernardino. The study area included twelve (12) encounter transects and twenty-nine (29) call play-back point locations that occurred within the boundaries of Chino Hills State Park. Encounter transects, call play-back points, and nest searches were the primary methods used to accomplish the study objectives. For ease of replication, encounter transects and call play-back points were located along roads using a random start systematic sampling design. Because the transects and play-back points were not randomly located throughout the park, results may only be reliable for the area surveyed. Although the results are likely representative for much of the park, they cannot be used in a predictive manner for portions of park that were not included in the sampling scheme. The regions of the park covered in the sampling schemes are detailed in Figures 1 and 2.

At least 25 raptor species have been observed or have potential to be observed at CHSP (Table 1). About half of these species are seasonal migrants that because of geographical range or habitat requirements do not reproduce within CHSP. The focus of this study was on species that are likely to breed within or near CHSP and can be divided into those

that are conspicuous to a casual observer and those that are inconspicuous. Since the study was focused on these nesting birds of prey, surveys were conducted in the spring and summer. A strong effort was made to conduct multi-date surveys under similar conditions (*e.g.*, time of day, weather conditions, sampling rate, distance, and personnel). Although there were some variation in field personnel over the length of the monitoring, the project lead (Lisa Fields) was present during all sampling sessions.

A concurrent study of raptors is being conducted by Bloom and Associates (714-544-6147) who banded birds near and within CHSP. Bloom and Associates last surveyed during Spring of 2001. Future surveys by this group will be conducted at a time and frequency not yet determined. Dave Bitner (760-765-1957) of the Raptor Institute (Ramona, CA) has experience with golden eagles in the vicinity.

Table 1. Potential Raptor Species Occurring at Chino Hills State Park.

COMMON NAME	*SCIENTIFIC NAME*	CONSERVATION STATUS	Nesting Potential at CHSP	Included in Survey Design
SWAINSON'S HAWK	*Buteo swainsoni*	CT (nesting)	Migrant-Outside Breeding Range	No
FERRUGINOUS HAWK	*Buteo regalis*	CSC, FSC, FWS: MNBMC, Audubon: Cal WL	Migrant-Outside Breeding Range	No
ROUGH-LEGGED HAWK	*Buteo lagopus*		Migrant-Outside Breeding Range	No
MERLIN	*Falco columbarius*	CSC (wintering)	Migrant-Outside Breeding Range	No
SHORT-EARED OWL	*Asio flammeus*	CSC, Audubon: Cal WL, FWS: MNBMC, PIF: Watch list	Migrant-Outside Breeding Range	No
OSPREY	*Pandion haliaetus*	CSC, CDF: Sensitive	Migrant-Breeding Habitat Not Present	No
BALD EAGLE	*Haliaeetus leucocephalus*	CE, FPD	Migrant-Breeding Habitat Not Present	No
PEREGRINE FALCON	*Falco peregrinus*	CE, CP, CDF: Sensitive, FWS: MNBMC	Migrant-Breeding Habitat Not Present	No
NORTHERN SAW-WHET OWL	*Aegolius acadicus*		Migrant-Breeding Habitat Not Present	No
TURKEY VULTURE	*Cathartes aura*		Nesting Habitat Present	Yes-Cons.
WHITE-TAILED KITE	*Elanus leucurus*	CP (nesting), FWS: MNBMC	Nesting Habitat Present	Yes-Cons.
NORTHERN HARRIER	*Circus cyaneus*	CSC	Nesting Habitat Present	Yes-Cons.
SHARP-SHINNED HAWK	*Accipiter striatus*	CSC (nesting)	Nesting Habitat Present	Yes-Incons.
COOPER'S HAWK	*Accipiter cooperi*	CSC (nesting)	Nesting Habitat Present	Yes-Incons.
RED-SHOULDERED HAWK	*Buteo lineatus*		Nesting Habitat Present	Yes-Incons.
RED-TAILED HAWK	*Buteo jamaicensis*		Nesting Habitat Present	Yes-Cons.
GOLDEN EAGLE	*Aquila chrysaetos*		Nesting Habitat Present	Yes-Cons.
AMERICAN KESTREL	*Falco sparverius*		Nesting Habitat Present	Yes-Cons.
BARN OWL	*Tyto alba*		Nesting Habitat Present	Yes-Incons.
WESTERN SCREECH OWL	*Otus kennicottii*		Nesting Habitat Present	Yes-Incons.
GREAT HORNED OWL	*Bubo virginianus*		Nesting Habitat Present	Yes-Incons.
LONG-EARED OWL	*Asio otus*	CSC	Migrant-Potential Nesting Habitat Present	Yes-Incons.
PRAIRIE FALCON	*Falco mexicanus*	CSC, Audubon: Cal WL	Low Potential But Within Breeding Range	No
NORTHERN PYGMY OWL	*Glaucidium gnoma*		Low Potential Typically Found at Higher Elevation	No
BURROWING OWL	*Athene cunicularia hypugea*	CSC, FSC, FWS: MNBMC, BLM: Sensitive	Burrowing Species - Within Breeding Range but Habitat Not Present	No

II. Methods

Based on behavioral characteristics, raptor species were classified as conspicuous (either commonly observed in flight or perching on exposed surfaces) or inconspicuous (raptors less commonly observed in flight or that are cryptic or more strongly associated with dense vegetation). Two different sampling methods were employed to capture conspicuous versus inconspicuous species. Details regarding these methods are provided below.

A). Conspicuous Species Methods

To sample for conspicuous species, driving encounter transects were established along ridge top roads throughout the park. To develop a representative sample of the park, transects were placed along ridges within all of the major watersheds including Skully Ridge, North Ridge, South Ridge, Sonome Canyon, and the west ridge in Coal Canyon (Figure 1). Because ridge routes were not accessible in the Bane Canyon and Upper Aliso watersheds, transects were located along Bane Canyon and Upper Aliso Roads. Sampling was conducted in the following sequence: South Ridge and Coal Canyon; Sonome Canyon and North Ridge; and then Bane Canyon, Upper Aliso, and Skully Ridge. To reduce spatial bias, a random start systematic sampling scheme was employed. Start points for each transect were generated at random using a ten-sided die. Each number on the die corresponded to a tenth of a mile. For example: if a four was rolled, then the survey started at 0.4 miles from the start of the defined survey area. From the random start point, every other mile of a particular ridge was surveyed as a separate transect. If a road was only a mile long, such as Sonome Canyon, then that mile of road was surveyed. Given the ability of an observer to distinguish raptors at a distance, it was assumed that approximately ¼ mile radius about each transect line was surveyed. Encounter transect mileage and locations are described in Table 2. Photos were taken at each point in the four cardinal directions (provided on the accompanying CD).

California Department of Parks and Recreation

Figure1.

Table 2. Locations of Conspicuous Raptor Encounter Transects at Chino Hills State Park.

Road Name	Encounter Transect Name	Mileage	Start Point Description	End point Description
Bane Canyon	BC1	0.0-1.0	Park entrance (intersection of Bane Canyon and Sapphire Roads)	1.0 mi. from intersection of Bane Canyon and Sapphire Roads
	BC2	2.0-3.0	2.0 mi. from intersection of Bane Canyon and Sapphire Roads	3.0 mi. from intersection of Bane Canyon and Sapphire Roads
Upper Aliso	UA1	0.0-1.0	End of pavement at the nursery	Before Intersection of Upper Aliso with Raptor Ridge
Skully Ridge	SkR1	0.8-1.8	Intersection of Lower Aliso and Skully Ridge Trail is 0.0, start transect at 0.8 along Skully Ridge Trail	Before the intersection of Skully Ridge and Brush Canyon Trail
Sonome Canyon	SoC1	0.0-1.0	Dirt Road just inside entrance gate at end of Lilac Road	1.0 mile point, before road forks
North Ridge	NR1	0.3-1.3	0.0 mileage at west intersection of North Ridge Trail and Telegraph Canyon Road. Start at 0.3 up the hill on North Ridge	1.3 mi. from intersection of North Ridge Trail and Telegraph Canyon Road
	NR2	2.3-3.3	2.3 mi. from intersection of North Ridge Trail and Telegraph Canyon Road	3.3 from intersection of North Ridge Trail and Telegraph Canyon Road
	NR3	4.3-5.3	4.3 from intersection of North Ridge Trail and Telegraph Canyon Road	5.3 mi. before reaching McDermont Trail
South Ridge	SR1	0.2-1.2	0.2 mi. west of intersection of South Ridge and Diemer Trails	1.2 mi. from intersection of South Ridge and Diemer Trails
	SR2	2.2-3.2	2.2 mi. from intersection of South Ridge and Diemer Trails	3.2 mi. from intersection of South Ridge and Diemer Trails
	SR3	4.2-5.2	4.2 mi. from intersection of South Ridge and Diemer Trails	5.2 mi. from intersection of South Ridge and Diemer Trails
Coal Canyon - West Ridge	WR1	0.0-1.0	0.0 mi. at end of the pavement in front of entrance gate	1.0 mi. from entrance gate, just past road to west

Encounter transects required two field personnel: a driver and an observer/recorder. Collection of conspicuous raptor species data occurred while driving at speeds between 10 and 15 miles per hour. All raptors encountered, either through visual or auditory identification, within a quarter mile of the transect were enumerated. Each sighting was assigned an observation number, species name and the sex and age class (if identifiable). The activity of each raptor was also recorded (*e.g.*, flying, perching, or kiting). The detection type (auditory or visual) was also noted. The distance along the transect of

each raptor sighting was measured (from odometer readings) and the distance (in meters) from the observer to raptor was estimated. The sight-angle of each individual was also recorded relative to the front of the survey vehicle in a clock-wise direction, to the raptor. For example, 0° is in front of the vehicle, 90° to the right, 180° behind the vehicle, and 270° to the left. Following a raptor observation any additional comments or observations were recorded.

Environmental measures including time (24 hour), temperature (°C), cloud cover (percent), wind speed (Beaufort scale), and precipitation was collected at the beginning of each transect. Sunrise, sunset and moon phase were also recorded for each sample date. A qualitative description of each transect area was recorded for each transect following quantitative data collection. The locations of the encounter transects were identified by using the vehicle's odometer. The length of the encounter transects were mapped using ArcInfo geographic information system (GIS) and an existing road data layer.

A single conspicuous species sampling session occurred once per month and was typically conducted over three days within the same week. Four separate sampling sessions occurred between April 23, 2001 and July 25, 2001.

Based on a review of the existing data (California Natural Diversity Database (CNDDB), WHR database, a Bloom and Associates study, and anecdotal accounts) the following conspicuous raptor species were expected to be observed during surveys: turkey vulture, white-tailed kite, red-tailed hawk, golden eagle, American kestrel, and northern harrier. Although not a raptor species, common raven observations were recorded to examine if raven observations are correlated with raptor observations at CHSP.

B). Inconspicuous Species

Surveys for inconspicuous species occurred at two time periods: during the day for diurnal species, and at night for nocturnal (owl) species. Call play-back points were spatially arranged along transects to represent the larger watersheds at CHSP including Bane, Upper and Lower Aliso, Coal, and Telegraph Canyons (Figure 2). Call play-back points were sampled at 0.5-mile intervals from a randomly determined starting point (random start systematic sampling design) and call play-back points were measured by vehicle odometer and mapped in the field using a Trimble GPS capable of 1-3 meter accuracy. (see Figure 2 and Table 3).

Figure2.

Table 3. Locations of call raptor play-back points at Chino Hills State Park.

Road Name	Call Play-back Point Name	Mileage	Start Point Description
Bane Canyon	BC1	0.6	0.6 mi. beyond Park entrance (intersection of Bane Canyon and Sapphire Roads) past entrance kiosk.
	BC2	1.1	In grassland at turnout.
	BC3	1.6	Under sycamores at turnout.
	BC4	2.1	Where road crosses creek at fire hook up.
	BC5	2.6	2.6 mi. at pavement above Bane Canyon Campground.
Upper Aliso	UA1	0.7	Proceed through Rolling M Ranch to Upper Aliso. Road begins at nursery. Point is 0.7 mi. up Upper Aliso under power lines, just past the intersection with Sidewinder Trail.
Telegraph Canyon	TC1	0.4	Begin at east end of Telegraph Canyon Road at Rolling M Ranch gate. First survey point is 0.4 mi. from gate, next to walnut tree.
	TC2	0.9	
	TC3	1.4	
	TC4	1.9	
	TC5	2.4	
	TC6	2.9	
	TC7	3.4	First survey session ends at TC7, 3.4 miles from gate, just past picnic tables under oak trees.
Telegraph Canyon	TC8	3.9	The second session begins at TC8, under a large oak.
	TC9	4.4	
	TC10	4.9	
	TC11	5.4	
	TC12	5.9	
	TC13	6.4	
	TC14	6.9	
	TC15	7.4	7.4 mi. at end of pavement after crossing culvert next to Sambucus tree.
Lower Aliso	LA1	0.6	0.0 at entrance to campground where vehicle leaves paved road. First point is 0.6 mi. down Lower Aliso, past first creek crossing.
	LA2	1.1	
	LA3	1.6	
	LA4	2.1	
	LA5	2.6	
	LA6	3.1	
	LA7	3.6	3.6 mi. Before gate at boundary along Green River Golf Course.
Coal Canyon	CoC1	0.6	0.6 mi. from entrance gate, where gas line crosses road.

The starting points were determined by a ten-sided die in the same manner as the conspicuous species surveys (described above). Transects and call play-back points were repeated in the same locations for both diurnal and nocturnal species. A hand held tape player with external speakers and a portable megaphone was used during call play-back surveys (copies of tapes provided in final submittal). The calls should be able to be broadcast over a distance of approximately 400 meters. Because of regional variation in raptor calls, locally-taped calls were used to increase the likelihood of response. Same species calls from outside the region should not be used in future monitoring efforts.

Inconspicuous diurnal surveys focused on three species: sharp-shinned hawk, red-shouldered hawk, and Cooper's hawk. These surveys were conducted in the afternoon, finishing at least 30 minutes prior to sunset. Diurnal species surveys were conducted once a month from April through July. Inconspicuous nocturnal surveys included four species: barn owl, western screech-owl, long eared owl, and great horned owl. Nocturnal surveys began at least 45 minutes after sunset and were conducted within several days surrounding the new moon. These surveys were also conducted once a month between March and July. Surveys required four different days to complete each month. The Telegraph Canyon transect was sampled over two separate days, TC1-7 on one day and TC8-15 on another. Lower Aliso and Coal Canyon were surveyed together, as were Bane Canyon and Upper Aliso.

Upon arrival at a transect, surveyors listened for two minutes for spontaneous calls and recorded environmental conditions (as described above for conspicuous species). Conditions were also recorded at the end of the survey at each point. If no spontaneous calls were heard the first call was broadcasted with the portable tape player and megaphone. The megaphone was held at chest height, for 30 seconds pointing at 120° from the transect line (The transect line follows the road, with 0° in front of the vehicle and 180° behind) followed by 30 seconds of silence while listening and watching for responses. The calls were repeated two (2) more times at the same 30 second call/30 second listening intervals at 240° and 360° degrees. Once the cycle was completed, surveyors listened and watched for two (2) more minutes before playing the next species call. If at any time during the process a target species responded, the response was documented and playing of that call was ceased. The call play-back order for diurnal species was sharp-shinned hawk, followed by the red-shouldered and Cooper's hawks. Nocturnal species call play-back began with the barn owl, then the western screech-owl, long eared owl and great horned owl. This sequence was followed so that the larger predators were called late in the order, so that they would not influence the calls (or lack of response) of smaller species.

Data recordation for inconspicuous species was similar to that of the conspicuous species encounter transects: each individual observation was assigned a number, then a sex and age class (if identifiable), the activity, detection type, detection distance (meters), and detection direction (degrees from the vehicle front). The last column of the data sheet should include a description of when a response was heard (*e.g.*, after the first playing of the tape or spontaneously upon arrival at the point). The bottom of the page was used to record any general comments. An example of a general comment is "people were

traveling through the point during diurnal survey". Additional information included the time, number of people, mode of transportation (*i.e.*, bike, horse, or on foot) and the direction they were heading. This type of information would be useful to determine if additional human presence during a sample point affects raptor species response.

C). Nest Monitoring

To locate raptor nests within the park all drivable roads, major drainages, and trails were traveled. Nests locations were identified by methodically searching appropriate habitat based on observed bcations of individuals. Potential raptor nesting habitats (sycamore trees, prominent trees or tall shrubs, cliff faces, and areas of repeated raptor observations) were carefully examined with a spotting scope and binoculars. Previously known nesting locations (from Bloom and Associates surveys) were also checked for activity and occupancy. All identified nests, including unoccupied ones, were revisited several times throughout the spring and summer to monitor use. Located nests were monitored, from a distance, for nesting numbers and fledgling success. After the young had fledged, the nests were again visited and their locations recorded using a GPS (Figure 3). Areas where raptors were observed exhibiting nesting behavior were also mapped even though nests were not located. Selected young were banded by Bloom and Associates in 2001.

D.) Sample Period and Intensity Estimates (Statistical Power to Detect Change Simulations).

To determine the ability of the sampling methodology to detect changes in species observations over time, statistical power simulations were conducted. A "power analysis" software (Monitor 6.3; Gibbs 1995) was used to perform these simulations under the following general parameters (specific parameters are provided in example files on the enclosed CD):

Individual species counts from all transects or all point were analyzed as single samples (means of n =12 transects for conspicuous species and n = 29 points for inconspicuous species) for each species. Estimates of sample mean, standard deviation, and coefficient of variation of the number of individuals for the 4 sample dates for each raptor species were used as parameters for the simulation. The sample frequency and single-season sampling intensity were compared between annual and biennial, and 4, 3, and 2 samples per season respectively. The sampling duration was assumed constant at ten years. A biennial sample would occur six (6) times and an annual period ten (10) times during a ten-year long effort. Sampling intensities and periods simulated are summarized in Table 4.

Figure 3.

Table 4. Sample frequency and intensity used in statistical power simulations.

Number of surveys per single sampling season (sampling intensity)	Annual surveys (10 over 10 years)	Biennial surveys (6 over 10 years)
4	40	24
3	30	18
2	20	12

III. Findings

A). Conspicuous Raptors

Encounter Transects

The twelve encounter transects combined represent approximately 4,900 acres (ca. 30 %) of Chino Hills State Park assuming a ¼ mile radius observation space about each transect. Based on this sample space red-tailed hawk and turkey vulture are the most abundant conspicuous species (Table 5).

Table 5. Number of raptors observed during encounter transects (n=12) at Chino Hills in 2001.

	Red-tailed hawk	Turkey vulture	American kestrel	Golden eagle	White-tailed Kite	Northern Harrier	Total Conspicuous Raptor Observations	Common raven
April	10	13	2	1	0	0	26	---
May	17	5	2	0	0	0	24	14
June	14	3	1	1	0	0	19	17
July	15	11	3	0	0	0	29	9
mean for all dates (st. dev.)	14 (2.9)	8 (4.8)	2 (0.8)	0.5 (0.6)	0 (0.0)	0 (0.0)	24.5 (4.2)	13.3 (4.0)
mean relative abundance or repsonsiveness	57 %	33 %	8 %	2 %	---	---	100%	---

American kestrels and golden eagles were least abundant. Anecdotal observations of white-tailed kite and northern harrier are commonly recorded at the park but they were not observed during spring or summer encounter transect surveys in 2001. Variation between sampling sessions was low for all conspicuous species except Turkey Vulture.

Mean abundance of common raven was relatively high. Although total number of raptors and number of common raven are highly inversely correlated (correlation coefficient (r) = -0.99) when compared by sample date, a transect by transect comparison shows no strong relationship between total raptors (r = 0.11), red-tail hawk (r = -0.03) or turkey vultures (r = 0.24). This would suggest that presence of raven did not affect raptor presence during surveys.

B). Inconspicuous Raptors

Diurnal Species

By combining the 29 call play-back points and assuming a 400 meter radius, approximately 3600 acres (ca. 20 %) of CHSP were sampled for inconspicuous diurnal species. Red-shouldered hawks were either the most abundant or most commonly detected species within this group (Table 6).

Table 6. Number of inconspicuous diurnal raptor responses to call play-back (n=29) at Chino Hills in 2001.

	Red-shouldered hawk	Cooper's hawk	Unknown juvenile	Sharp-shinned hawk	Total Inconspicuous Diurnal Raptor Observations
April	3	1	0	0	4
May	3	3	0	0	6
June	6	2	0	0	8
July	3	3	1	0	7
mean for all dates (st. dev.)	3.8 (1.5)	2.3 (1.0)	0.3 (0.5)	0 (0.0)	6.3 (1.7)
mean relative abundance or repsonsiveness	60 %	35 %	5 %	---	100 %

Because the number of individuals observed was relatively low (ranging from 4 to 7), relative species abundance within this group is probably not a meaningful measure. Two of the observed Cooper's hawks during July were nestlings, the nest was less than 50 meters from the point. The unknown juvenile hawk observed in July was not identifiable to species. Sharp-shinned hawks were not observed during the surveys. Because Chino Hills State Park is on the edge of the potential breeding range and has potential habitat for the sharp-shinned hawk, monitoring for this species should continue.

Nocturnal Species

Based on the same 29 call play-back points, inconspicuous nocturnal species were considerably more responsive or abundant than diurnal species (Table 7). Western screech-owl was the most commonly observed of the nocturnal species. Barn owl and great horned owl were less commonly detected, occurring at less than half the relative abundance of western screech-owl. The variability between sampling dates was relatively low for western screech owl and barn owl. Variability was moderately high for great horned owl because of the lack of observations during the final sampling period (June). No long-eared owls were detected during the 2001 sampling and only one has ever been documented at CHSP (near the Santa Ana River; Bloom pers. comm.); however, CHSP is within the breeding range of the species and appropriate habitat appears to be present within the park. Because of the sensitivity of this species and its previous and potential presence, additional monitoring is warranted.

Table 7. Number of owl responses to call play-back (n=29) each month at Chino Hills in 2001.

	Western Screech-Owl	Barn Owl	Great Horned Owl	Unknown	Long Eared Owl	Total Inconspicuous Nocturnal Raptor Observations
March	25	6	13	2	0	46
April	24	10	9	0	0	43
May	24	11	9	0	0	44
June	27	13	0	3	0	43
mean for all dates (st. dev.)	25 (1.4)	10 (2.9)	7.8 (5.5)	1.3 (1.5)	0 (0.0)	44 (1.4)
mean relative abundance or repsonsiveness	57 %	23 %	18 %	3 %	---	100 %

C.) Nest Monitoring

Surveys of raptor nesting habitat occurred near all roads and major drainages within CHSP. A total of twenty-one (21) nests and eight (8) breeding territories were identified during these surveys (Table 8).

Table 8. Number of raptor nests and territories, by species, observed at Chino Hills in 2001.

Species	Nests Observed	Successful Nests (>/= 1 fledgling)	Success %	Territory Only (display of nesting behavior)
Red-tailed hawk	11	7	64	0
Unoccupied	4	---	---	---
Red-shouldered hawk	2	2	100	1
Cooper's hawk	1	1	100	2
Golden eagle	1	1	100	2
Great horned owl	1	0	0	0
Common raven	1	1	100	0
American kestrel	0	---	---	3
Total	22	12	67 % (of 18 occupied nests)	8

The relatively large number of Red-tailed hawk nests observed is a reflection of both its high relative abundance within the park (refer to Table 4) and the conspicuity of their nesting sites. Relatively few of the remaining raptors at CHSP were observed nesting. This is likely due to either low abundances or cryptic nesting sites. Western screech-owl, barn owl, and great horned owl were frequently observed during call play-back surveys yet only a single nest was observed. Owl nests are typically difficult to locate. American kestrels were relatively common and nesting behavior was observed near tree cavities. Since the nests were not visible, nest monitoring was not feasible for this study. Additionally, Turkey vultures were common but their nests are difficult to locate because

they do not construct well-formed nests or nest within inconspicuous locations (*e.g.,* cliff face caves).

Of the eighteen (18) nests that were observed as occupied, approximately 67% were successful in fledging at least one individual. Only four of the red-tailed hawk, and the only great horned owl nest observed were unsuccessful. The Cooper's hawk was unique in that it nested late, not laying eggs until the middle of June, when the other birds were fledging.

Raptor nesting occurred in a variety of vegetative and landscape features. All of the red-tailed and red-shouldered hawk nests were located in sycamore trees. American kestrels exhibiting nesting behavior were associated with cavities within sycamores trees. The lone Cooper's hawk nest was observed in a willow tree (*Salix* sp.), while the golden eagle pair nested on a cliff face ledge. Both great horned owl and common raven occupied nests in sycamores previously used by red-tailed hawks. It is apparent that mature sycamore trees are important to a majority of the nesting raptors in the park.

IV. Data Management

Software Packages used in the data analysis and production of this report include Microsoft (MS) Word 2000, MS Excel 2000, ArcView GIS version 3.2, and Monitor 6.3. Digital versions of the report, graphics, GIS data (ArcView shapefiles), data files and data forms are included on a CD in a pocket following the appendices. A copy of the Monitor software is also included. Documentation for this software can be downloaded from http://www.MP1-PWRC.USGS.GOV/powcase/monitor.html.

V. Future Monitoring Plan

Based on the first season's sampling effort, field experience, and a statistical power analysis, the monitoring sample design appears to be robust for most of the raptor species at CHSP. In general, the sampling effort should be repeated in year-two (2003) to provide a better between-season estimate of the variation in species abundances. Estimates of between-season (sampling period) variation were set conservatively based on the between transect variation over four samples [the coefficient of variation (cv) ranged between 0.7 for great horned owl and 0.1 for western screech owl]. A second year of data may reveal a lower estimate and a significantly higher power to detect change. This would likely allow a significant reduction in sampling effort. If staff time and effort are limited for the next season, a reduced number (3 instead of 4) of within season sampling for most raptor species should still be reliable. Since the overall goal is to conserve biodiversity, it is more important to detect decreases in abundance than increases. The appropriate level of power to detect change depends on the level of risk the district is willing to accept for missing detection of a 10% or greater decrease in relative abundance. Suggestions for continued monitoring efforts are provided for the three different raptor behavioral groups (conspicuous, inconspicuous diurnal, and inconspicuous nocturnal.) below:

A). Conspicuous Species Surveys

In general, statistical power to detect change was higher for species observed at higher frequencies and that had low variation in numbers from sample to sample. Based on a statistical power simulation, the efficiency of sampling intensity is estimated for the four conspicuous raptor species in Table 9 below.

Table 9. Statistical power simulation for conspicuous species observed in 2001. Probability of detecting a 10% or greater change in abundance (increase and decrease) between sampling seasons over a 10-year period.

	4 surveys annually		4 surveys biennially		3 surveys annually		3 surveys biennially		2 surveys annually		2 surveys biennially	
	Increase	Decrease	Inc.	Dec.	Inc.	Dec.	Inc.	Dec.	Inc.	Dec.	Inc.	Dec.
Red-tail Hawk	100	100	100	99	100	100	100	99	100	96	99	91
Turkey Vulture	86	78	85	75	83	69	81	65	79	59	73	59
American Kestrel	95	70	94	70	95	62	92	65	90	47	91	51
Golden Eagle	54	11	48	8	53	8	48	8	50	6	41	7

Statistical power for detecting change for red-tailed hawk species is strong for all within-season or between-season sampling rates that were simulated. The remaining conspicuous species had lower statistical power to detect change but a reduced sampling

rate would not significantly reduce this statistical power. A reduction in survey rates from annually to biennially would probably be appropriate for all species except golden eagle. Because golden eagles territories are very large, their nesting habitat is limited to a few locations at CHSP, and only two were observed during transects, it would be more appropriate to census this species individually (only 3 to 4 golden eagle pairs are known to occur within or within close proximity to CHSP and one of these pairs is known to nest within the park). Again, a second season of data and repeated analysis of power data may reveal that sampling effort could be reduced further while still maintaining the ability to detect change.

Because encounter transects only required 5-10 minutes each, environmental conditions minutes to survey were not substantively different between the start and end of encounter transects. Future surveys need only record environmental conditions at the beginning of each transect.

Based on the field observations of mating and nesting behavior, and to minimize field effort (by sampling conspicuous and inconspicuous species, and nest monitoring in the same months) surveys for conspicuous species should begin in March instead of April.

B). Inconspicuous Species Surveys

Diurnal Inconspicuous Species

Because of lower numbers of individuals encountered and greater variation in within-season samples, statistical power to detect change is slightly lower for diurnal inconspicuous species than for conspicuous species (Table 10). Statistical power remains high enough to detect at least 10 percent changes in the number of individuals, and sampling period can probably be reduced to biennial surveys without much loss in power (2-4%).

Table 10. Statistical power simulation for inconspicuous diurnal species. Probability of detecting a 10% or greater change in abundance between samples over a 10-year period.

	4 surveys annually		4 surveys biennially		3 surveys annually		3 surveys biennially		2 surveys annually		2 surveys biennially	
	Increase	Decrease	Inc.	Dec.	Inc.	Dec.	Inc.	Dec.	Inc.	Dec.	Inc.	Dec.
Red-shouldered Hawk	95	88	96	86	91	84	93	79	91	72	87	67
Cooper's Hawk	93	70	89	66	88	62	88	59	84	48	83	46
Unknown	---	---	---	---	---	---	---	---	---	---	---	---
Sharp-shinned Hawk	---	---	---	---	---	---	---	---	---	---	---	---

Statistical power analyses were not conducted for an unknown (unidentified) species or sharp-shinned hawk. Additionally, surveys for inconspicuous diurnal species should begin in March instead of April to be consistent with future sampling for conspicuous species, and inconspicuous nocturnal species.

Nocturnal Inconspicuous Species

Based on simulations, statistical power to detect change was relatively high for nocturnal inconspicuous species (Table 11). For western screech-owl and barn owl, sampling period or intensity can likely be reduced to three (3) surveys biennially over ten years without significant change in power; However, great horned owl would likely require at least four (4) surveys biennially to reliably detect a 10% percent change in number of individuals. If sampling is reduced from four (4) to three (3) within-season surveys, they should occur in March, April, and May.

Table 11. Statistical power simulation for inconspicuous nocturnal species. Probability of detecting a 10% or greater change in abundance between samples over a 10-year period.

	4 surveys annually		4 surveys biennially		3 surveys annually		3 surveys biennially		2 surveys annually		2 surveys biennially	
	Increase	Decrease	Inc.	Dec.	Inc.	Dec.	Inc.	Dec.	Inc.	Dec.	Inc.	Dec.
Western Screech-Owl	100	100	100	100	100	100	100	100	100	100	100	100
Barn Owl	99	97	98	95	99	95	99	93	98	86	97	83
Great Horned Owl	83	74	80	72	81	71	73	63	74	56	68	50
Unknown	---	---	---	---	---	---	---	---	---	---	---	---
Long Eared Owl	---	---	---	---	---	---	---	---	---	---	---	---

C). Nest Monitoring

Because of the qualitative nature of locating nests, and because nests may be utilized by different species each year, or a pair may alternate nests between years, a statistical power analysis is not appropriate. Although the quantitative monitoring methods (described above) generally suggest monitoring frequency may be reduced to every other year, it is recommended that nest monitoring is performed annually. Annual nest monitoring would allow a better estimate of the distribution of nests in the park, and would provide for annual monitoring of reproductive success. Surveys should begin in late February, before the sycamores have fully leafed out. During this time of year, the nests are more visible. Efforts should be coordinated with either Pete Bloom or Dave Bitner to have golden eagle nesting sites monitored by helicopter, when possible. It appears that the nest in the vicinity of Coal Canyon is not visible from the ground.

VI. Contact Information

This report was prepared by Lisa Fields, and Darren Scott Smith, AstSPRE Southern Service Center (SSC). Lisa Fields located at the Gold Mines Sector, Gold Fields District of California State Parks located in Grass Valley, CA. Karen Miner, Senior State Park Resource Ecologist, SSC provided assistance with sample design and statistical analysis. Karen Miner, Kim Marsden SSC, and Roy Woodward, Environmental Specialist IV, Natural Heritage Section also provided insightful comments and editorial assistance.

Field data collection was provided by staff from several offices, including Southern Service Center, Inland Empire District, and Chino Hills State Park staff. Southern Service Center: Karen Miner, Lisa Fields, Brady VanDragt (ESI – Natural Resources), and Michelle Fredrickson (Student Assistant). Inland Empire District: Amy Palkovic (AstSPRE), Gary Lyons (Ranger), Brooke Lyons (ESI), Craig Yamashita (Park Aid), Meagan Bristol (Park Aid), and Jacob Hughes (Park Aid).
The nestling banding was conducted by Lisa Fields, Pete Bloom, Susan Gallaugher, and Joe Papp under permits held by Bloom & Associates.

VII. References

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